DOCUMENT RESUME

ED 468 579 EC 309 170

AUTHOR	Warger, Cynthia
TITLE	Helping Students with Disabilities Participate in Standards-Based Mathematics Curriculum. ERIC/OSEP Digest.
INSTITUTION	ERIC Clearinghouse on Disabilities and Gifted Education, Arlington, VA. ERIC/OSEP Special Project.
SPONS AGENCY	Special Education Programs (ED/OSERS), Washington, DC.
REPORT NO	EDO-EC-06
PUB DATE	2002-07-00
NOTE	4p.; ERIC/OSEP Digest Number E628.
CONTRACT	ED-99-CO-0026
AVAILABLE FROM	ERIC Clearinghouse on Disabilities and Gifted Education, Council for Exceptional Children, 1110 North Glebe Rd., Arlington, VA 22201-5709. Tel: 800-328-0272 (Toll Free); Fax: 703-620-2521; e-mail: ericec@cec.sped.org; Web site: http://www.ericec.org.
PUB TYPE	ERIC Publications (071) -- ERIC Digests in Full Text (073)
EDRS PRICE	EDRS Price MF01/PC01 Plus Postage.
DESCRIPTORS	*Academic Accommodations (Disabilities); *Academic Standards; *Assistive Technology; Computer Assisted Instruction; Computer Software; *Disabilities; Educational Assessment; Elementary Secondary Education; Mathematics Curriculum; *Mathematics Instruction; *Problem Solving; Student Participation
IDENTIFIERS	ERIC Digests

ABSTRACT

This digest discusses how selected researchers are informing practice in four key areas relating to the participation of students with disabilities in standards-based mathematics curriculum. The first area focuses on enhancing students' understanding of mathematics and emphasizes the need to make math meaningful for students with disabilities. The second area discusses teaching students strategies for mathematical problem solving. It describes "Solve It!," an approach that incorporates the cognitive processes critical to mathematical problem solving in each step of the strategy. Steps include: reading the problem, paraphrasing, visualizing, hypothesizing about problem solutions, estimating the answer, computing, and checking the problem. In this approach, students also learn a metacognitive strategy that they apply at each step. The strategy includes saying aloud what the problem is asking them to do, asking themselves if they understand the problem, and checking their progress. The digest then discusses how assistive technology for students with disabilities can enhance their participation in a standards-based mathematics curriculum, including using interactive software for students who are blind and using a CD-ROM for students who use American Sign Language. The digest closes with a discussion on making accommodations to support student participation in state and district assessments. (CR)

Reproductions supplied by EDRS are the best that can be made
from the original document.

ED 468 579

ERIC DIGEST

Helping Students with Disabilities Participate in Standards-Based Mathematics Curriculum

ERIC/OSEP Digest

E628

EDO-EC-06

July 2002

Cynthia Warger

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)
This document has been reproduced as received from the person or organization originating it.
Minor changes have been made to improve reproduction quality
Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

ERIC Clearinghouse on Disabilities and Gifted Education
1110 North Glebe Road
Arlington, Virginia 22201-5704
1-800-328-0272
ericec@cec.sped.org
http://ericec.org

EC 309 170

BEST COPY AVAILABLE

ERIC Clearinghouse on Disabilities and Gifted Education
1110 North Glebe Road, Arlington, Virginia 22201-5704
1-800-328-0272 ericec@cec.sped.org http://ericec.org

OSEP Digest E628

EDO-EC-06 July 2002

Helping Students with Disabilities Participate in Standards-Based Mathematics Curriculum

Cynthia Warger

The bar on what students with disabilities are expected to learn was raised by the 1997 Amendments to the Individuals with Disabilities Education Act (IDEA), which emphasize students' participation and progress in the general education curriculum. Navigating the general education math curriculum has become a key to student success.

The mathematics curriculum has changed over the last 20 years due to educational reforms driven by standards. A significant element driving this change is the National Council of Teachers of Mathematics (NCTM) Principles and Standards for School Mathematics (first published in 1989 and revised in 2000), which focus on conceptual understanding and problem solving rather than procedural knowledge or rule-driven computation. Most states and districts have used the NCTM Standards to some degree in revamping their mathematics curricula. [For more information, visit the NCTM web site at http://standards.nctm.org.]

The challenge for teachers is to provide effective math instruction to students with disabilities so they can meet the high standards set for what all students must be able to know and do mathematically. Unfortunately, many students with disabilities experience difficulties with the reformed math curriculum. As University of Maryland researchers Paula Maccini and Joe Gagnon have found, students may have difficulty processing and distinguishing relevant information, have deficits in computational skills, or lack reasoning and problem-solving skills. But with the right support, students with disabilities can succeed in a higher level math curriculum.

For many years, the US Department of Education, Office of Special Education Programs (OSEP) has supported research to improve mathematics achievement for students with disabilities. This ERIC/OSEP Digest examines how selected researchers are informing practice in four areas: enhancing students' understanding of mathematics, teaching students mathematical problem-solving strategies, using assistive technology in instruction and assessment, and making accommodations to support student participation in state and district-wide assessments.

Enhancing Student's Understanding of Mathematics

John Cawley, Professor Emeritus at the University of Connecticut, has found that for students with disabilities to do better in math, math must be meaningful for them. Both knowing and doing mathematics must be emphasized to enhance the quality of mathematics instruction and learning for students with disabilities.

Knowing about mathematics means that the student comprehends the basic principles of a mathematics problem, knows there is more than one way to explain the mathematics of the problem, and knows that there is frequently more than one acceptable answer. This is in contrast to doing mathematics, which means the student can apply a number of different strategies and mathematics principles to complete an item. Cawley believes that many of the difficulties students face with math stem from educators' neglecting the "knowing" and overemphasizing the "doing".

Consider this example that highlights the distinction between knowing about subtraction and being able to do subtraction. Subtraction as a mathematical topic is much more meaningful than the rote computation take-away approach that has been advocated for students with disabilities since the 1920s. It is a process that allows the student to understand and find the difference between two numbers. The big idea for students to understand is that subtraction represents a difference. Knowing about subtraction involves reasoning in the form of proof and explanation. It also involves the ability to demonstrate the connectedness between one facet of mathematics (e.g., subtraction) and another (e.g., addition). Cawley has found that understanding subtraction in this way offers teachers numerous opportunities to stress number sense and skill development, which can result in improved student understanding and performance.

Teaching Students Strategies for Mathematical Problem Solving

According to University of Miami researcher Marjorie Montague, a major focus of the NCTM standards and of reformed math curriculum is problem solving. Her research has shown that effective mathematical problem solving depends on the ability to select and apply task-appropriate cognitive and metacognitive processes and strategies for understanding, representing, and solving problems. Montague describes cognitive processes as the "to do" strategies and metacognitive processes as the reflective strategies (e.g., "What am I doing?" and "What have I done?").

To help teachers understand the knowledge and skills needed for effective and efficient mathematical problem solving, Montague developed Solve It!, an approach that incorporates the cognitive processes critical to mathematical problem solving in each step of the strategy:

- **Reading the problem.** Students are taught how to read mathematical problems, including using reading strategies to understand the problem (e.g., focusing on important information), developing mathematical vocabulary, and recognizing when they do not understand relationships among mathematical terms and quantitative concepts expressed in a problem.

- **Paraphrasing.** Students are taught how to put the problem into their own words and convey meaning.
- **Visualizing.** Students are taught to draw a representation on paper or to make a mental image of the problem.
- **Hypothesizing about problem solutions.** Students are taught how to decide the number of operations that are needed to solve the problem, select and order the operations, and then to transform the information into correct equations and algorithms.
- **Estimating the answer.** Students are taught how to stay focused on the type of outcome (e.g., number of yards rather than feet), and then how to predict the answer by using the information in the problem and their projected solution path.
- **Computing.** Students are taught how to recall the correct procedures for working through the algorithms and the necessary math facts for accuracy.
- **Checking the problem.** Students are taught how to check the mathematical problem solving process to ensure that they have understood the problem, accurately represented the problem, selected an appropriate solution path, and solved the problem correctly.

In the Solve It! approach, students also learn a metacognitive strategy that they apply at each step. The strategy includes the following steps:

- **Say** aloud or to themselves what the problem is asking them to do.
- **Ask** themselves if they understand the problem.
- **Check** their progress.

Using Assistive Technology for Instruction and Assessment

IDEA provides that assistive technology will be considered for students with disabilities as part of their individualized education program (IEP) planning. Researchers have made significant advancements in providing technology tools to support mathematics achievement. Examples include the following:

- **Interactive software for students who are blind.** Many students who are blind are unable to read or write the symbols that comprise mathematics, and thus, must learn concepts and perform calculations entirely in their heads, limiting their ability to master the intricacies of mathematics. To address this need, Gaylen Kapperman and Jodi Sticken of Northern Illinois University developed an interactive software tutorial that helps them to study the Nemeth Code (the Braille code of mathematics). The software is installed in a Braille Lite—a small, portable Braille notetaker that is equipped with synthetic speech and a refreshable Brailled display.
- **A CD-ROM for students who use American Sign Language (ASL) to communicate.** Using multimedia, Jean Andrews and Donald Jordan at Lamar University developed the Meet the Math Wiz CD-ROM series that helps students focus on math word problems over six grades of math difficulty using multicultural names, stories, and themes. The program features Chris Kurtz, a math teacher who is deaf. He welcomes users to his castle, where he describes, among other things, a four-point plan for solving math word problems. He leads users into eight demonstrations per CD, giving them an ASL translation of the problem, an animation hint, and an explanation of how to solve the problem in ASL.

Making Accommodations to Support Student Participation in State and District Assessments

Most State and district-wide assessments tap mathematical knowledge and skills. Given the controversy surrounding the use of accommodations as evidenced by state policy analysis, it is important to know what the research currently indicates in order to help make appropriate accommodation decisions.

To help practitioners access emerging research that addresses accommodations for students with disabilities, Martha Thurlow at the National Center on Educational Outcomes has created an online, searchable data base of accommodations (http://education.umn.edu/NCEO/AccomStudies.htm). The database allows

References

Andrews, J. & Jordan, D. (Undated). *Meet the Math Wiz*. (CD-ROM). Curriculum Publications Clearinghouse, Horrabin Hall 46, Western Illinois University, 1 University Circle, Macomb, IL 61455, 800-322-3905. http://www.wiu.edu/users/micpc/index.html

Cawley, J. (2002). Mathematics interventions and students with high incidence disabilities. *Remedial and Special Education, 23*(1), 2-6.

Freedom Scientific, Inc. *Nemeth Code Self-Study Instructional Material*. Download from http://www.freedomscientific.com/fs_downloads/notenemeth.asp (July 2002).

Gagnon, J., & Maccini, P. (2001). Preparing students with disabilities for algebra. *Teaching Exceptional Children, 34*(1), 8-15.

Montague, M., Applegate, B., & Marquard, K. (1993). Cognitive strategy instruction and mathematical problem-solving performance of students with learning disabilities. *Learning Disabilities Research and Practice, 8*(4), 223-232. For more information, contact Montague at outreach@Miami.edu.

BEST COPY AVAILABLE

ERIC/OSEP Digests are in the public domain and may be freely reproduced and disseminated, but please acknowledge your source. This digest was prepared with funding from the Office of Special Education Programs (OSEP), U.S. Department of Education, under Contract No. ED-99-CO-0026. The opinions expressed in this publication do not necessarily reflect the positions of OSEP or the Department of Education.

U.S. Department of Education
Office of Educational Research and Improvement (OERI)
National Library of Education (NLE)
Educational Resources Information Center (ERIC)

NOTICE

Reproduction Basis

	This document is covered by a signed "Reproduction Release (Blanket)" form (on file within the ERIC system), encompassing all or classes of documents from its source organization and, therefore, does not require a "Specific Document" Release form.
X	This document is Federally-funded, or carries its own permission to reproduce, or is otherwise in the public domain and, therefore, may be reproduced by ERIC without a signed Reproduction Release form (either "Specific Document" or "Blanket").